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AIR UNIVERSITY

School of AVIATION MEDICINE

PHYSIOLOGICAL RECOGNITION OF STRAIN IN FLYING PERSONNEL

Eosinopenia in F-86 Combat Operations

(Title-Unclassified)

PROJECT NUMBER 21-1208-0005
REPORT NUMBER 2

PROJECT REPORT

RESTRICTED
Security Information

USAF School of Aviation Medicine, Project No. 21-1208-0005, Report No. 2.

Physiological Recognition of Strain in Flying Personnel: Eosinopenia in F–86 Combat Operations. (Title–Unclassified)

Thaddeus J. Domanski, USAF School of Aviation Medicine, Randolph Field, Texas.

25 pp & iii. 17 illus. 27 cm. RESTRICTED (Security Information)

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Missions selected on the basis of a relative uniformity of data collection suggest that eosinopenia following a *routine* combat mission was significantly associated with *weak* or *very weak* combat pilots ($P < .01$). The absence of an eosinopenia following a *difficult* combat mission was limited to *superior, average,* or *better than average* combat pilots. The distinction between *routine* and *difficult* combat missions is based upon the presence of air-to-air combat. Evaluations of combat performance were made by supervisory flying personnel.

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Eosinopenia in F–86 Combat Operations

(Title– Unclassified)

THADDEUS J. DOMANSKI, Lieutenant Colonel, USAF (MSC)

Department of Flight Medicine

PROJECT NUMBER 21-1208-0005
REPORT NUMBER 2

Air University

USAF SCHOOL OF AVIATION MEDICINE
RANDOLPH FIELD, TEXAS
September 1953

PRECIS

OBJECT:

To investigate the existence of a demonstrable relationship between eosinopenia and F–86 combat missions (Korea).

SUMMARY:

1. Recognizable combat stresses encountered by F–86 pilots in Korea are described. Associated eosinophil findings are presented and discussed.

2. Eosinopenia was frequently but not invariably associated with the F–86 combat missions studied.

3. Missions selected on the basis of a relative uniformity of data collection suggest that eosinopenia following a *routine* combat mission was significantly associated with *weak* or *very weak* combat pilots ($P < .01$). The absence of an eosinopenia following a *difficult* combat mission was limited to *superior, average,* or *better than average* combat pilots. The distinction between *routine* and *difficult* combat missions is based upon the presence of air-to-air combat. Evaluations of combat performance were made by supervisory flying personnel.

EOSINOPENIA IN F–86 COMBAT OPERATIONS

It was suggested by General Benson* that a study of the actual combat situation might logically constitute the next step in our investigations relative to eosinopenia associated with flying. It was with his help that we were subsequently able to make a study of U.S. Air Force bombardment and fighter operations in the Far East. The present paper deals with data derived from the use of the blood eosinophil count in the study of F–86 combat missions in Korea.

These data were collected during July and August 1952–principally during the first six days of August. For the unit concerned, the intensity of combat activity on 1 August and again on 6 August equaled or surpassed that of any previous day of F–86 operations in Korea. On 1 August this unit flew 3 missions for a total of 96 sorties. Three MIGs were destroyed. One F–86 was lost to MIG–15 gunfire, with the pilot *missing in action*. Four other aircraft sustained battle damage. The action on 1 August had followed about six days of practically no flying, due to weather. On 6 August this unit flew 22 missions for a total of 140 sorties. Five MIGs were destroyed. Two aircraft sustained battle damage.

Twenty subjects were studied with respect to one or more combat missions. One additional subject (subject V) was studied with respect to a training (F–86 transition) mission. Sixteen of the 21 subjects were selected by the Director of Operations (Wing), whose object it was to assemble a representative group of F–86 combat pilots, including personnel with varying amounts of F–86 combat experience. Two of the subjects (S and T) were studied at the request of the Wing Commander. Subjects C, K, V, and Z were selected by this investigator. Subjects K, V, and Z were added on the basis of their unusual or atypical combat experience. Subject C was included because of his apparent attitude toward combat. The subjects were drawn from each of the three squadrons composing a single wing. The study included a total of 78 man-days of which 41 were flying days and 37 were nonflying days. Data were collected with respect to 53 air missions including 2 training flights and 51 combat missions. There occurred 31 instances of 1 combat mission and 7 instances of 2 combat missions flown during a single day. During a day of extraordinary enemy activity (6 August), each of two pilots flew 3 combat missions. These remarks pertain to the time span of the study proper (29 July to 9 August, inclusive), and, for any given subject, refer only to those flying days during which eosinophil counts were drawn.

A summary of the subjects' personal and military background data is shown in table I. Except for such illnesses as are described elsewhere in this paper, the subjects enjoyed a state of apparent good health. Their age range was 22 to 31 years, the average being 27.7 years. Of the 20 subjects studied with respect to combat missions, 5 were flight leaders, 4 were element leaders, and the remainder flew as wingmen. It will be observed (table I) that there were relatively few times when these subjects, while flying F–86 combat missions, had actually engaged the enemy. Indeed, prior to 1 August, these subjects had only seldom sighted a MIG. Such findings are consistent with the fact that the occurrence of combat between the F–86 and the MIG has been determined, to a very important extent, by the enemy's willingness to fight. In view of these circumstances, any attempt to relate the skill and the aggressiveness of individual friendly pilots to the number of enemy aircraft each has destroyed or damaged should be made only in the light of detailed knowledge concerning the enemy's disposition toward actual combat during specific months, weeks, and days, and even specific missions. The rapidity with which F–86 pilots amass combat missions, after they have been declared battle-ready, is analogously influenced by the extent and distribution of MIG activity and by other circumstances essentially beyond the control of the individual pilot.

Table II constitutes a summary of the subject's military flying experience. This table is arranged

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*Brigadier General Otis O. Benson, Jr., USAF (MC), Commandant, USAF School of Aviation Medicine.

TABLE I

Summary of subjects' personal and military background data

Subject		A	B	C	D	E	H	I	J	K	L	M	N	O	P	R	S	T	V	W	X	Z
Rank		1st Lt.	1st Lt.	Maj.	Capt.	1st Lt.	1st Lt.	Capt.	2d Lt.	Maj.	1st Lt.	Capt.	Capt.	2d Lt.	Capt.	2d Lt.	1st Lt.	1st Lt.	Maj.	Capt.	2d Lt.	Capt.
Age		25	24	31	28	23	25	29	25	29	28	29	31	22	28	23	28	29	31	29	29	28
Marital status		S	S	M	M	S	S	M	S	M	M	M	M	S	S	S	M	M	M	M	M	M
Months overseas (current tour)		4	4	6	1	3	5	12	6	9	9	3	4	6	1	3	10	3	4	16	5	15
Date of separation from previous active military service		Aug. 1946	NA	NA	Jan. 1947	NA	Dec. 1946	Jan. 1947	NA	Oct. 1945	Nov. 1945	Jan. 1946	Feb. 1946	NA	Nov. 1946	NA	Nov. 1946	Feb. 1946	NA	Feb. 1946	Dec. 1946	Nov. 1945
Date of re-entry into active military service		Nov. 1950	NA	NA	Feb. 1950	NA	June 1948	Feb. 1951	NA	Jan. 1951	Jan. 1950	Feb. 1951	Mar. 1951	NA	Aug. 1950	NA	Feb. 1951	May 1951	NA	Aug. 1950	Sept. 1948	Jan. 1951
Number of F-86 combat missions flown		73	85	94	6	45	80	43	33	20	31	56	58	23	6	65	30	7	0	42	8	8
(a) Number of missions during which enemy was engaged		5	4	6	1	3	6	3	1	2	7	5	6	3	0	4	0	0	0	8	1	2
(b) Aircraft destroyed		½	1	3	0	0	1	1	0	1	1	0	3½	0	0	1	0	0	0	2	0	0
(c) Aircraft damaged		0	0	2	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	2	0	0
Present status	Flight leader			x				x				x	x						NA	x		
	Element leader	x				x	x										x		NA			
	Wingman		x		x				x	x	x			x	x	x		x	NA		x	x

NA – Not applicable.
S – Single.
M – Married.

according to the order of rank of each subject relative to the respective categories of experience. *Total flying time* and *Total jet flying time* include Reserve flying time. *Total combat flying time* includes World War II combat flying time and pertains only to fighter pilot time, except in the case of subject D. Of the 582 combat hours shown for subject D, 574 hours had been earned as a pilot in B-17 type aircraft during World War II. Subject X, with 53 hours of total combat flying time (F-80 and F-86) had to his credit an additional 200 hours of combat time as a gunner in TBF-type aircraft (World War II). In the case of 12 of the 21 subjects (57 percent), combat experience in Korea had been derived

TABLE II

Summary of subjects' military flying experience

Order of rank	Total flying time (hours)	Total jet flying time (hours)	Total combat flying time (hours)	Number of combat missions (Korea)	Number of F-86 combat missions (Korea)
1	D (2,545)	C (1,442)	M (693)	Z (228)	C (94)
2	V (2,544)	H (702)	Z (660)	C (196)	B (85)
3	N (2,539)	W (488)	D (582)	I (89) S (89)	H (80)
4	C (2,478)	P (442)	W (377)	B (85)	A (73)
5	M (1,685)	V (420)	C (363)	L (83)	R (65)
6	Z (1,599)	Z (286)	K (341)	H (80)	N (58)
7	P (1,567)	R (210)	V (250)	A (73)	M (56)
8	S (1,481)	A (202)	I (210)	R (65)	E (45)
9	I (1,413)	B (198)	P (188)	N (58)	I (43)
10	K (1,304)	N (196)	S (165)	M (56)	W (42)
11	W (1,267)	E (173)	L (164)	V (50)	J (33)
12	H (1,214)	X (169)	T (161)	E (45)	L (31)
13	L (994)	M (156)	B (141)	J (43)	S (30)
14	T (954)	D (126)	H (115)	W (42)	O (23)
15	A (484)	J (75)	A (103)	X (33)	K (20)
16	R (479)	I (70)	N (96)	O (26)	X (8) Z (8)
17	B (469)	S (67)	R (83)	K (20)	T (7)
18	X (446)	L (65)	J (61)	T (7)	D (6) P (6)
19	E (441)	O (63)	E (60)	D (6) P (6)	V (0)
20	J (426)	K (53)	X (53)		
21	O (406)	T (50)	O (37)		

entirely from flying the F–86 type aircraft (subjects A, B, D, E, H, K, M, N, P, T, and W). Of the remaining subjects, 5 (subjects I, J, L, O, and S) had gained prior combat experience in Korea in the P–51, 1 (subject X) in the F–80, 1 (subject C) in the P–51 and the F–80, 1 (subject Z) in the P–51 and the F–84, and 1 (subject V) in the U.S. Navy jet aircraft. Eight of the 21 subjects (38 percent) had flown in combat as fighter pilots during World War II (subjects I, K, M, P, T, V, W, and Z). Subject C was unusual in that he possessed a total of 575 hours of F–86 flying time. The remaining subjects had less than 200 hours' total F–86 flying time; 13 of these had less than 100 hours of such time. The above information was derived from records available at Combat Operations, supplemented by pilot questionnaire and interview, and includes the last day on which eosinophil counts were drawn on each of the subjects.

The technique of the eosinophil count was the same as that previously employed (1, 2). It should be added, however, that it has been our routine practice to avoid exposure of the filled pipettes to direct sunlight, and to store them, prior to counting, in an insulated box internally cooled by melting ice. In general, counts drawn relative to each air mission included: (1) an initial count drawn shortly before take-off (ATD), and (2) one or more counts drawn post-flight (ATA). The actual pre- and post-flight relationships achieved, constitute a part of table IV. Sensibly the same patterns were followed on nonflying days. With few exceptions, counts were drawn in the de-briefing room of the combat operations building. Nonflying days were essentially days of rest for the pilots concerned. Occasionally, part-time administrative duties were performed. Meals followed the conventional military pattern. Food consumption between meals was limited, almost entirely, to noncarbonated soft drinks.

After each mission a single investigator questioned each subject concerning the details of the mission flown and the day's activities. A predetermined check list was used for this purpose; it was applied at the times that serial counts were drawn. A corresponding inventory of activities was developed for nonflying days. Combat Intelligence was also employed as a source of information relative to the intimate character of the combat missions concerned. To this end, de-briefing personnel filled out a questionnaire concerning each of the missions flown by each of the subjects. As had been projected, such information heavily overlapped that obtained from the post-flight interview previously mentioned. Additionally, the same investigator who conducted post-mission interviews listened to much of the radio chatter associated with all but one (31 July) of the missions studied, and attended one or more of the de-briefings which followed such missions. At the conclusion of the study an attempt was made to obtain an evaluation of the several subjects as pilots, particularly as combat pilots. Three supervisory flying officers familiar with the combat performance of the individual subjects, functioned as critics. For members of one of the squadrons (subjects D, E, H, L, N, P, R, S, and Z) comments were obtained from the Director of Operations (Wing), who regularly flew with that squadron. For members of the two remaining squadrons (subjects A, B, C, I, J, K, M, O, T, V, W, and X), comments were obtained from the respective Squadron Commanders. Each of the three critics rendered his remarks separately and without benefit of any preliminary summary of the experimental findings. The resultant evaluations are summarized in table III.

Blood eosinophil count data are shown in table IV. In order to disguise the duration of combat missions and thereby reduce the security classification of the present paper, the actual time of arrival (ATA) is omitted. Time relationships between the ATA and the associated changes in blood eosinophil count are preserved, however, by indicating the time elapsed between ATA and the time at which the respective post-flight counts are drawn. All of the missions were airborne for very nearly the same length of time, unless otherwise noted. For training missions, the security precaution is obviously unnecessary. With respect to the nonflying day data, it was possible to provide essential coverage of major portions of the diurnal cycle involved in the combat missions flown by the respective subjects. The percentage change in eosinophil count is variously represented (table IV) as Δ_1, Δ_2, and Δ_3. The percentage change between pre-flight (or initial) and subsequent counts is expressed by Δ_1, between second and subsequent counts by Δ_2, and between third and fourth counts by Δ_3. For nonflying days, the *pre-flight count* is, in effect, the initial or base-line count. Table IV also includes brief notes relative to the character of the mission flown. The *Routine combat mission* was characterized by the absence of an air-to-air engagement. The *Difficult combat mission* is defined as one during which there occurred an air-to-air engagement to the extent that the friendly pilot made one or more firing passes, had firing passes made against him, or both. *Weather* is used as a qualifying remark when

the pilot had been forced to fly by instruments during at least one-third of the total flight. The stated, fundamental distinction between a *routine* and a *difficult* combat mission was acceptable to all of the subjects as well as to other combat pilots and supervisory personnel of the unit concerned. The accordance of special importance to *weather* was indorsed by each of the approximately 30 combat pilots questioned. The several missions are further described in the text. The term *eosinopenia*, unless otherwise qualified, refers to a decrease in blood eosinophil count of 50 percent or more, or to the finding of a blood eosinophil count of the order of 40 cells/mm.[3] Figures 1 through 17 present a graphic summary of the observed patterns of blood eosinophil response.

TABLE III

Evaluation of subjects as combat pilots by supervisory flying personnel

Subject A:	Has made excellent progress and is now an "above average" combat pilot.
Subject B:	Very aggressive and very calm in the air. A good pilot.
Subject C:	A superior fighter pilot. Extremely aggressive; very eager to tangle with the enemy.
Subject D:	"Roger" is his only answer to in-flight orders. "Would go through a stone wall if you asked him to."
Subject E:	Weak. "Would not want him on my wing."
Subject H:	Will make a good leader. Very hurt when scolded; carries hurt for weeks.
Subject I:	Most experienced pilot in his squadron. Very thorough. Very demanding.
Subject J:	Doing a good job. High strung.
Subject K:	Good average pilot. Has terrific motivation (source unknown) to fly the F–86. Has overcome initial inexperience; improvement phenomenal.
Subject L:	Worries a great deal. Eager to get home. If aircraft gets a single rough moment (e.g., bad fuel) he returns to the base.
Subject M:	Ranks low as a combat pilot. Not aggressive in the air. On the ground, panics when questioned.
Subject N:	A good pilot. Courageous. Being persuaded to fly more often than he would if he limited himself to his normal turn. Much affected by loss of wing man (combat), a month ago.
Subject O:	Relatively new at flying the F–86, but regarded as being a very aggressive combat pilot. Has had the "breaks against him" in that he has been associated with three "accidents," none of which are considered to have been the fault of this subject. Subject is characterized by a remarkable ability to "bounce back" from any arduous or disastrous experience.
Subject P:	Too new at flying the F–86, for a proper evaluation. Has had more than an average amount of experience at flying jets (noncombat).
Subject R:	Regarded as being a "very good follower." It is thought that the confidence now lacking, will develop with further experience. Had a near fatal landing accident about two months ago.
Subject S:*	"Bothered from the time that he goes to a briefing." A "very worried individual." In the air, "always tries to avoid combat"; "always says that he had not heard you" relative to in-flight information concerning a near or potential encounter with the enemy.
Subject T:*	"A very weak, unstable pilot" who shows no desire to "mix it up with the enemy." "Has become almost hysterical on the radio when his flight was chasing and fighting MIGs." Will be removed from combat flying status.
Subject V:	Very eager to fly. Seems very sure of self, very cool. "His cockpit check was superior; knew everything." (*NOTE:* Comments concerning this subject apply only to training missions in the F–86.)
Subject W:	Very competent. Extremely aggressive. Very cool in emergency situations. "A real tiger."
Subject X:	Now a "good, average pilot." Was weak when first checked out in the F–86.
Subject Z:	Too new in the F–86 for a proper evaluation. His previous combat flying in Korea causes him to know the area in which he will fly. This knowledge is held to constitute an important advantage.

*Subjects S and T were removed from combat flying status before the finish of this study.

TABLE IV
Eosinophil data

Subject	Date	Number of missions flown	Mission number	Pre-flight count cells/mm.³	Post-flight count cells/mm.³	Percentage change			Nature of mission
						Δ_1	Δ_2	Δ_3	
A	29 July	0	NA	113(0903 hours)	129(1612 hours)	+15	NA	NA	Nonflying day
	1 Aug.	2	(1)*	164(0727 hours) ATD(1)−1.2 hr.	28 ATA(1)+0.2 hr.	−83	NA	NA	Difficult combat mission
			(2)	NA	21 ATA(1)+4.2 hr. ATA(2)+0.6 hr.	−88	−27	NA	Routine combat mission, plus weather
	2 Aug.	1	(1)	128(0829 hours) ATD(1)−5.1 hr.	68 ATA(1)+0.7 hr.	−47	NA	NA	Routine combat mission, plus weather
					44 ATA(1)+2.5 hr.	−66	−35	NA	
B	29 July	0	NA	125(0909 hours)	127(1111 hours) 181(1604 hours)	+2 +45	NA +43	NA NA	Nonflying day
	1 Aug.	2	(1)*	158(0722 hours) ATD(1)−1.2 hr.	41 ATA(1)+0.1 hr.	−74	NA	NA	Difficult combat mission
			(2)	NA	18 ATA(1)+4.3 hr. ATA(2)+0.4 hr.	−89	−57	NA	Routine combat mission
					36 ATA(1)+6.7 hr. ATA(2)+2.9 hr.	−78	−11	+100	
	2 Aug.	0	NA	158(0850 hours)	213(1612 hours)	+35	NA	NA	Nonflying day
	3 Aug.	1	(1)	125(0937 hours) ATD(1)−0.6 hr.	122 ATA(1)+5.4 hr.	−3	NA	NA	Routine combat mission
	6 Aug.	3	(2)	NONE	53 ATA(1)+3.3 hr. ATA(2)+0.3 hr.	NA	NA	NA	(1) Routine combat mission (2) Difficult combat mission
			(3)	NA	38 ATA(1)+6.5 hr. ATA(2)+3.5 hr. ATA(3)+0.3 hr.	−29	NA	NA	(3) Routine combat mission
	7 Aug.	0	NA	163(0834 hours)	NONE	NA	NA	NA	Nonflying day
C	9 Aug.	1	(1)*	166(0815 hours) ATD(1)−1 hr	124 ATA(1)+0.7 hr.	−25	NA	NA	Routine combat mission
					183 ATA(1)+5.9 hr.	+10	+48	NA	

Table IV (Continued on next page)

Table IV (Continued)

	31 July	0	NA	206(1808 hours)	159(1103 hours) 189(1612 hours)	−23 −8	NA +19	NA NA	Nonflying day
	1 Aug.	1	(1)*	197(0724 hours) ATD(1)−1.2 hr.	153 ATA(1)+0.1 hr.	−22	NA	NA	Routine combat mission
	2 Aug.	0	NA	166(0834 hours)	199(1604 hours)	+20	NA	NA	Nonflying day
D	6 Aug.	2	(1)*	152(0944 hours) ATD(1)−1.1 hr.	161 ATA(1)+0.2 hr.	+6	NA	NA	Routine combat mission
					203 ATA(1)+3.6 hr.	+34	+26	NA	
			(2)*	NA	133 ATA(1)+6.9 hr. ATA(2)+0.3 hr.	−12	−17	−35	Difficult combat mission
E	9 Aug.	1	(1)*	614(0755 hours) ATD(1)−1.4 hr.	247 ATA(1)+0.2 hr.	−60	NA	NA	Routine combat mission
					327 ATA(1)+4.2 hr.	−47	+32	NA	
	29 July	0	NA	102(0905 hours)	89(1116 hours)	−12	NA	NA	Nonflying day
					77(1614 hours)	−25	−14	NA	
	1 Aug.	1	(1)*	136(1135 hours) ATD(1)−1 hr.	80 ATA(1)+0.2 hr.	−41	NA	NA	Routine combat mission
					141 ATA(1)+3 hr.	+3	+76	NA	
	2 Aug.	0	NA	186(0840 hours)	144(1550 hours)	−23	NA	NA	Nonflying day
H	5 Aug.	1	(1)*	141(1517 hours) ATD(1)−1.1 hr.	89 ATA(1)+0.5 hr.	−36	NA	NA	Difficult combat mission
	6 Aug.	2	(1)	NONE	116(1454 hours) ATA(1)+0.2 hr.	NA	NA	NA	Difficult combat mission
			(2)	NA	53 ATA(1)+4.9 hr. ATA(2)+0.3 hr.	−54	NA	NA	Routine combat mission
	7 Aug.	0	NA	128(0849 hours)	NONE	NA	NA	NA	Nonflying day
	31 July	0	NA	66(0803 hours)	67(1114 hours) 26(1605 hours)	+2 −60	NA −61	NA NA	Nonflying day
	1 Aug.	2	(1)	83(0726 hours) ATD(1)−1.2 hr.	36 ATA(1)+0.2 hr.	−56	NA	NA	Difficult combat mission; destroyed his first MIG
I					33 ATA(1)+3.7 hr.	−60	−9	NA	
			(2)	NA	27 ATA(1)+6.8 hr. ATA(2)+0.9 hr.	−68	−19	−19	Training mission
	2 Aug.	0	NA	69(0925 hours)	102(1614 hours)	+48	NA	NA	Nonflying day

Table IV (Continued on next page)

Table IV (Continued)

Subject	Date	Number of missions flown	Mission number	Pre-flight count cells/mm.^{3}	Post-flight count cells/mm.^{3}	Percentage change Δ_1	Percentage change Δ_2	Percentage change Δ_3	Nature of mission
J	29 July	0	NA	131(0901 hours)	138(1113 hours) 106(1610 hours)	+5 −19	NA −23	NA NA	Nonflying day
	3 Aug.	2	(1)	72(0934 hours) ATD(1)−1.2 hr.	106 ATA(1)+5.1 hr. ATA(2)+0.3 hr.	+48	NA	NA	Routine combat mission (flew as spare)
			(2)*	NA	124 ATA(1)+8.7 hr. ATA(2)+3.9 hr.	+72	+17	NA	Routine combat mission
	5 Aug.	1	(1)	NONE	68(1500 hours) ATA(1)+0.4 hr.	NA	NA	NA	Difficult combat mission
					92 ATA(1)+2.6 hr.	+35	NA	NA	
K	6 Aug.	1	(1)	NONE	121(1436 hours) ATA(1)+0.4 hr.	NA	NA	NA	Difficult combat mission; destroyed his first MIG
	7 Aug.	0	NA	211(0755 hours)	NONE	NA	NA	NA	Nonflying day
	8 Aug.	1	(1)*	211(0900 hours) ATD(1)−0.9 hr.	156 ATA(1)+0.3 hr.	−26	NA	NA	Routine combat mission
					259 ATA(1)+4.3 hr.	+23	+66	NA	
L	29 July	0	NA	253(0911 hours)	274(1118 hours) 253(1606 hours)	+8 0	NA −8	NA NA	Nonflying day
	31 July	0	NA	NONE	230(1600 hours)	NA	NA	NA	Nonflying day
	1 Aug.	1	(1)*	294(0755 hours) ATD(1)−0.7 hr.	139 ATA(1)+0.3 hr.	−53	NA	NA	Difficult combat mission
					113 ATA(1)+6.7 hr.	−62	−15	NA	
	2 Aug.	0	NA	193(0838 hours)	181(1610 hours)	−6	NA	NA	Nonflying day
M	31 July	0	NA	89(0909 hours)	78(1101 hours) 78(1610 hours)	−13 −13	NA 0	NA NA	Nonflying day
	1 Aug.	2	(1)*	NONE	43(1038 hours) ATA(1)+0.3 hr.	NA	NA	NA	Difficult combat mission
			(2)	NA	41 ATA(1)+4.2 hr. ATA(2)+0.5 hr.	NA	−4	NA	Routine combat mission, plus weather
	2 Aug.	1	(1)	94(0848 hours) ATD(1)−4.8 hr.	77 ATA(1)+0.7 hr.	−18	68	NA	Routine combat mission, plus weather
					25 ATA(1)+2.7 hr.	−73	−68	NA	
	6 Aug.	1	(1)	86(1003 hours) ATD(1)−0.8 hr.	106 ATA(1)+4.3 hr.	+24	NA	NA	Routine combat mission

Table IV (Continued on next page)

Table IV (Continued)

	1 Aug.	1	(1)	88(0813 hours) ATD(1)−4.4 hr.	22 ATA(1)+0.3 hr.	−75	NA	NA	Routine combat mission
	2 Aug.	0	NA	109(0855 hours)	80(1652 hours)	−27	NA	NA	Nonflying day
	3 Aug.	1	(1)	81(0935 hours) ATD(1)−0.6 hr.	23 ATA(1)+3.8 hr.	−59	NA	NA	Routine combat mission
	5 Aug.	0	NA	41(1020 hours)	80(1910 hours)	+97	NA	NA	Nonflying day
N	6 Aug.	2	(1)	69(0941 hours) ATD(1)−1.2 hr.	71 ATA(1)+0.1 hr.	+3	NA	NA	Routine combat mission
					28 ATA(1)+3.2 hr.	−59	−60	NA	
			(2)	NA	16 ATA(1)+7.2 hr. ATA(2)+0.5 hr.	−77	−78	−44	Difficult combat mission
	7 Aug.	0	NA	64(0822 hours)	NONE	NA	NA	NA	Nonflying day
	1 Aug.	1	(1)*	NONE	59(1044 hours) ATA(1)+0.4 hr.	NA	NA	NA	Difficult combat mission; flew wing for pilot shot down during this mission
O					46 ATA(1)+7 hr.	−23	NA	NA	
	2 Aug.	0	NA	156(0842 hours)	NONE	NA	NA	NA	Nonflying day
	5 Aug.	0	NA	186(1025 hours)	189(1610 hours)	+2	NA	NA	Nonflying day
	29 July	0	NA	341(0927 hours)	341(1120 hours) 438(1608 hours)	0 +29	NA +29	NA NA	Nonflying day
	1 Aug.	1	(1)	541(0717 hours) ATD(1)−1.3 hr.	194 ATA(1)+0.2 hr.	−64	NA	NA	Routine combat mission*
P	2 Aug.	1	(1)	427(0836 hours) ATD(1)−5 hr.	238 ATA(1)+0.4 hr.	−44	NA	NA	Routine combat mission, plus weather
					193 ATA(1)+1.8 hr.	−55	−19	NA	
	5 Aug.	1	(1)	338(1545 hours) ATD(1)−0.8 hr.	368 ATA(1)+0.4 hr.	+9	NA	NA	Routine combat mission; came home early because of hung tanks
	31 July	0	NA	143(0759 hours)	94(1105 hours) 196(1615 hours)	−34 +38	NA +109	NA NA	Nonflying day
R	1 Aug.	1	(1)*	227(0547 hours) ATD(1)−2.8 hr.	44 ATA(1)+0.6 hr.	−81	NA	NA	Difficult combat mission; destroyed his first MiG
	2 Aug.	0	NA	118(0331 hours)	83(1608 hours)	−29	NA	NA	Nonflying day
	6 Aug.	1	(1)	NONE	138(1504 hours) ATA(1)+0.2 hr.	NA	NA	NA	Routine combat mission
	31 July	0	NA	102(0756 hours)	53(1110 hours) 61(1557 hours)	−48 −40	NA +15	NA NA	Nonflying day

Table IV (Continued on next page)

Table IV (Continued)

Subject	Date	Number of missions flown	Mission number	Pre-flight count cells/mm.^{3}	Post-flight count cells/mm.^{3}	Percentage change Δ_1	Percentage change Δ_2	Percentage change Δ_3	Nature of mission
S	1 Aug.	1	(1)*	100(0545 hours) ATD(1)−2.9 hr.	27 ATA(1)+0.1 hr.	−73	NA	NA	Difficult combat mission
	2 Aug.	0	NA	161(0853 hours)	74(1606 hours)	−54	NA	NA	Nonflying day
T	29 July	0	NA	100(0907 hours)	80(1109 hours) 103(1602 hours)	−20 +3	NA +29	NA NA	Nonflying day
	31 July	1	(1)*	NONE	44(1915 hours) ATA(1)+1.3 hr.	NA	NA	NA	Routine combat mission
	1 Aug.	0	NA	121(0723 hours)	86(1110 hours) 156(1657 hours)	−29 +30	NA +81	NA NA	Nonflying day
	2 Aug.	0	NA	177(0857 hours)	136(1556 hours)	−23	NA	NA	Nonflying day
V	8 Aug.	(1)	(1)	105(0745 hours) ATD(1)−0.4 hr.	74 ATA(1)+0.4 hr.	−30	NA	NA	Training mission; second transition flight in F−86 type aircraft
					127 ATA(1)+4.2 hr.	+21	+72	NA	
W	31 July	0	NA	428(0811 hours)	370(1108 hours) 352(1608 hours)	−14 −18	NA −5	NA NA	Nonflying day
	1 Aug.	1	(1)*	346(0745 hours) ATD(1)−0.9 hr.	330 ATA(1)+0.1 hr.	−5	NA	NA	Difficult combat mission; damaged 1 MIG
					249 ATA(1)+4 hr.	−28	−25	NA	
	2 Aug.	0	NA	455(0846 hours)	403(1553 hours)	−11	NA	NA	Nonflying day
	6 Aug.	1	(1)	NONE	341(1437 hours) ATA(1)+0.4 hr.	NA	NA	NA	Difficult combat mission; destroyed his 1st and 2d MIGs
	7 Aug.	0	NA	459(0839 hours)	NONE	NA	NA	NA	Nonflying day
	29 July	0	NA	221(0858 hours)	199(1107 hours) 169(1600 hours)	−10 −24	NA −15	NA NA	Nonflying day
	1 Aug.	1	(1)	343(0715 hours) ATD(1)−1.4 hr.	156 ATA(1)+0.1 hr.	−54	NA	NA	Routine combat mission; flew spare; flamed out during return to base and blew out all tires on landing
					91 ATA(1)+4.0 hr.	−74	−42	NA	
					117 ATA(1)+6.8 hr.	−66	−25	+29	
	2 Aug.	0	NA	306(0844 hours)	228(1616 hours)	−26	NA	NA	Nonflying day
	3 Aug.	1	(1)	NONE	205(1532 hours) ATA(1)+5.2 hr.	NA	NA	NA	Routine combat mission
	5 Aug.	1	(1)*	171(1513 hours) ATD(1)−2.1 hr.	136 ATA(1)+0.3 hr.	−21	NA	NA	Routine combat mission

Table IV (Continued on next page)

Table IV (Continued)

X	6 Aug.	3	(1)	NONE	144(1014 hours) ATA(1)+0.2 hr.	NA	NA	NA	Routine combat mission; flew spare; returned early because of hung tank
					99 ATA(1)+2.3 hr.	−31	NA	NA	
			(2)	NA	12 ATA(1)+5.2 hr. ATA(2)+0.1 hr.	−14	+25	NA	Difficult combat mission; landed without power
			(3)	NA	36 ATA(1)+7.8 hr. ATA(2)+2.8 hr. ATA(3)+0.1 hr.	−75	−63	−71	Routine combat mission
	7 Aug.	0	NA	186(0842 hours)	NONE	NA	NA	NA	Nonflying day
Z	31 July	0	NA	102(1604 hours)	NONE	NA	NA	NA	Nonflying day
	2 Aug.	1	(1)	NONE	80(1523 hours) ATA(1)+0.5 hr.	NA	NA	NA	Routine combat mission
	9 Aug.	1	(1)	172(0754 hours) ATD(1)−1.1 hr.	78 ATA(1)+0.1 hr.	−54	NA	NA	Routine combat mission
					100 ATA(1)+4.5 hr.	−42	+28	NA	

NA: Not applicable.
ATD: Actual time of departure.
ATA: Actual time of arrival.

*Missions which constitute the group of 19 missions referred to under "Comments."

For orientation purposes, we may consider the patterns of response associated with a routine combat mission in the case of subjects C, E, K, and Z, along with that of subject V when the latter flew a training mission (figure 1). It will be observed that for subjects K and C the count fell an approximate 25 percent shortly after the termination of the respective flights, and that 4 to 6 hours post-flight, a decidedly reverse process was manifest. For subject V, flying his second transition flight (F-86), the picture was quite the same. In contrast, subjects E and Z showed a drop in count of more than 50 percent shortly after the completion of their respective flights, followed by a relatively moderate upturn in count at approximately 4.5 hours post-flight. It was mentioned earlier that subject C had been selected as a subject on the basis of his apparent attitude toward combat. This followed from informal discussions with pilots of the unit studied, in the course of which subject C stood out as one who by his own assertion was totally devoid of conscious emotion when engaged with the enemy. Several months after the conclusion of this study, subject C became this country's greatest living jet ace, a distinction which he maintained until after his return to the zone of the interior.

Subject P (figure 2) flew a routine combat mission on each of three days—1, 2, and 5 August. The first of these was of average duration; the second and third were approximately a half hour shorter. During

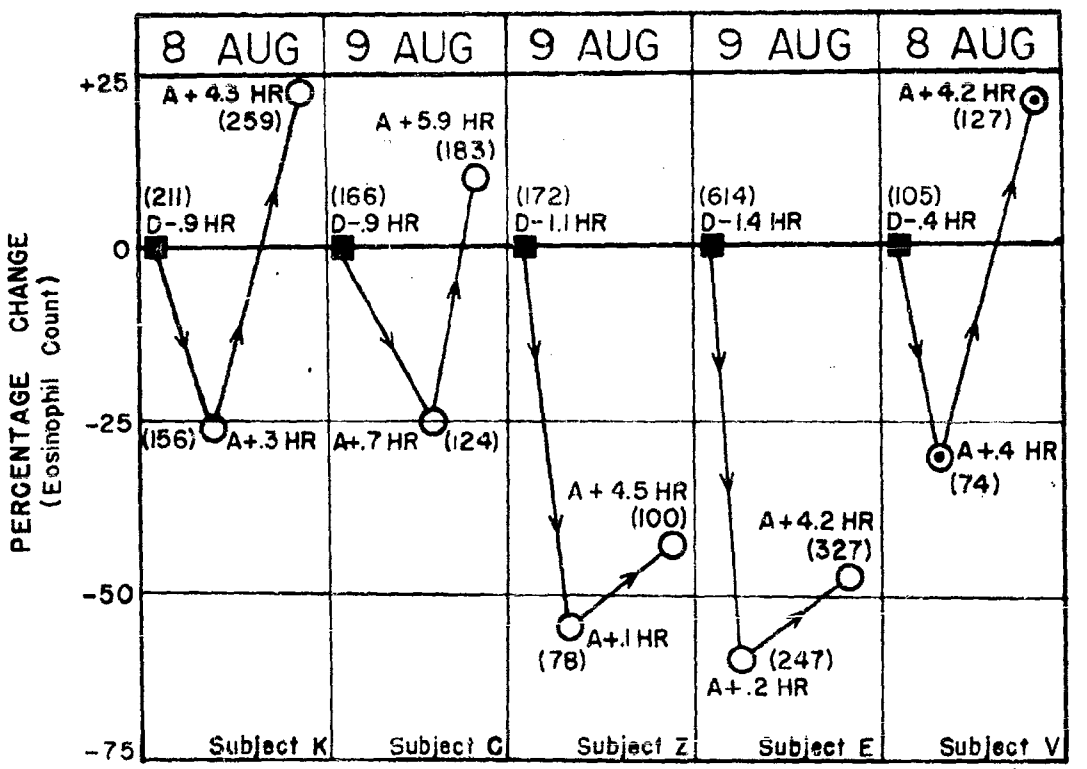

FIGURE 1. Subjects K, C, Z, E, and V.

Key (figures 1–17):

■ *Pre-flight or initial blood eosinophil count, with cells/mm.³ shown in parentheses.*

D. Actual time of departure.

A. Actual time of arrival.

———o *Nonflying day.*

———●→ ***Difficult combat mission.***

———○→ ***Routine combat mission.***

———◎→ ***Training mission.***

the first mission subject P saw some aircraft which "might have been MIGs." With respect to enemy activity the second mission was "much easier" than the first, but subject P said that it caused him "some sweat" because about two-thirds of the mission had been flown in *weather*. On the third mission, subject P broke off early because of *hung tanks*. He saw no enemy aircraft, real or potential. Because of the hazard he could not afford to invite combat, even if the opportunity had presented itself. The post-flight change in eosinophil count for this mission, was negligible, whereas the first mission was associated with a post-flight eosinopenia. In the case of the second mission, the initial post-flight count showed a moderate fall which became more pronounced at 1.8 hours post-flight. It will be observed that on 2 August the reactions of subject M (figure 3) and A (figure 4) to the same *weather* mission mentioned above were similar to that observed for subject P. Subject M volunteered that he was "bothered more by weather than by MIGs." Subject T, who was subsequently grounded for lack of aggressiveness on combat missions, had a count of only 44 cells/mm.³ after flying a clearly routine combat mission. On nonflying days, this subject did not show an eosinopenia (figure 5).

Subjects L, O, and R provided examples of an eosinopenia associated with a difficult combat mission. Subject L (figure 6; 1 August) began to run low on fuel while being fired upon by two MIGs. In order to break away he made a dive into surrounding cloud banks at an altitude of approximately 5,000 feet. He knew that in this area there are mountain peaks which rise to 4,800 feet and he was "very scared" as to the potential consequences of his dive. Subject O was firing or being fired upon by MIGs during much of the mission represented in figure 7. On this mission, too, he was flying as

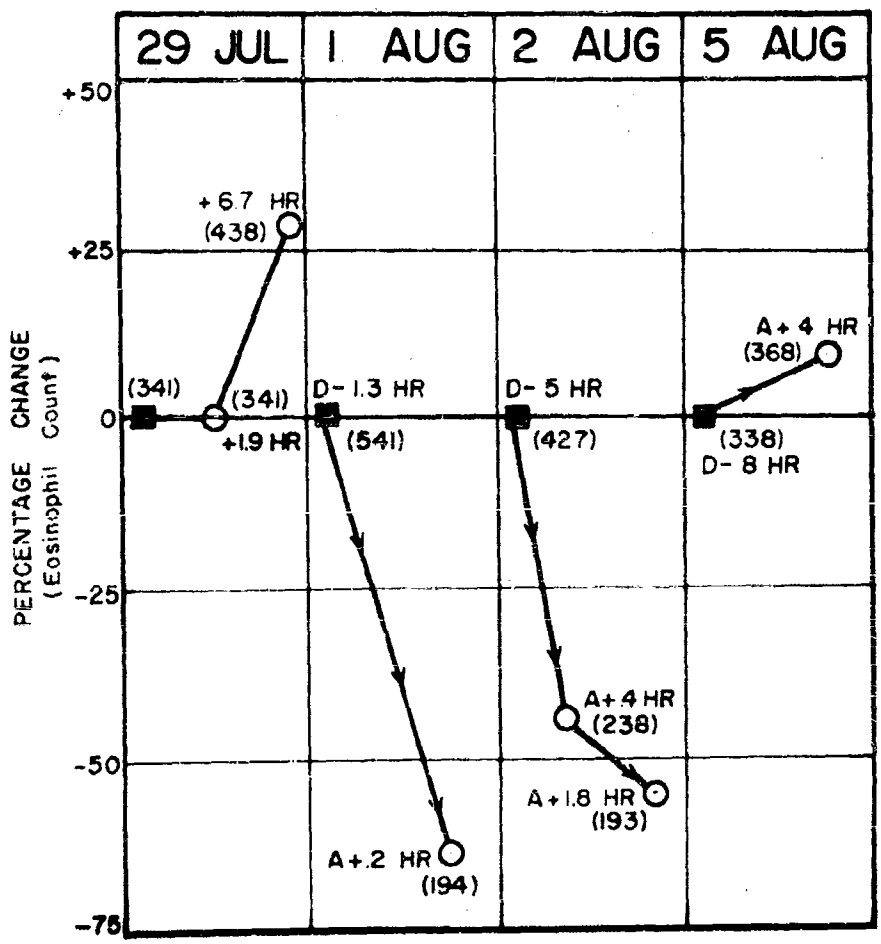

FIGURE 2. *Subject P.*

wingman for his Squadron Commander, who was shot down and *missing in action*. Subject O said that this was the "worst of all" missions he had flown. He "knew that he would be grounded" because of the loss of his Squadron Commander. Shortly after the first post-flight count had been drawn, this did indeed occur. However, it was an administrative grounding and he was returned to combat flying status several days later. A comparison of the post-flight count (59 cells/mm.^{3}) with the corresponding nonflying day count (186 cells/mm.^{3}) leaves little doubt as to the occurrence of a post-flight eosinopenia. Subject R was engaged with the enemy for about 15 minutes during his 1 August mission (figure 8) during which time he destroyed his first MIG. He described himself as having been "pretty excited and a little scared" during the latter battle. During the mission and the night before he had been troubled with indigestion. Subject S (figure 9) had his first experience with being shot at on 1 August. Initially, a MIG chased him through a turn of 180 degrees, firing intermittently; later another MIG made an extended firing pass. His description of the mission was characterized by an attitude of alarm and of very frank surprise over having served as a target. He volunteered that he had been "very scared" during the mission and termed it the "worst of all" F-86 missions he had flown. He was grounded two days later and subsequently sent home. According to his Wing Commander, subject S "had never fired his guns" during any of the combat missions. On one occasion, very shortly before the scheduled start of a briefing (combat mission) subject S was observed stopping several pilots on their way to the briefing to ask about the rumored existence of a new administrative device which he might employ to get home before the completion of his F-86 combat tour. The incident commanded our attention at the time of its occurrence because of the seemingly poor timing of the questions and because this was the first (and only) time we heard one of these pilots associate *going home* with something other than the desire to get 100 combat missions as soon as possible and to become an *ace*. After he found out that he would go home, subject S expressed concern over the possibility that people at home might think that he was "shook up."

In the case of subject W (figure 10) difficult combat missions were not associated with a post-flight eosinopenia. During his 1 August mission, subject W

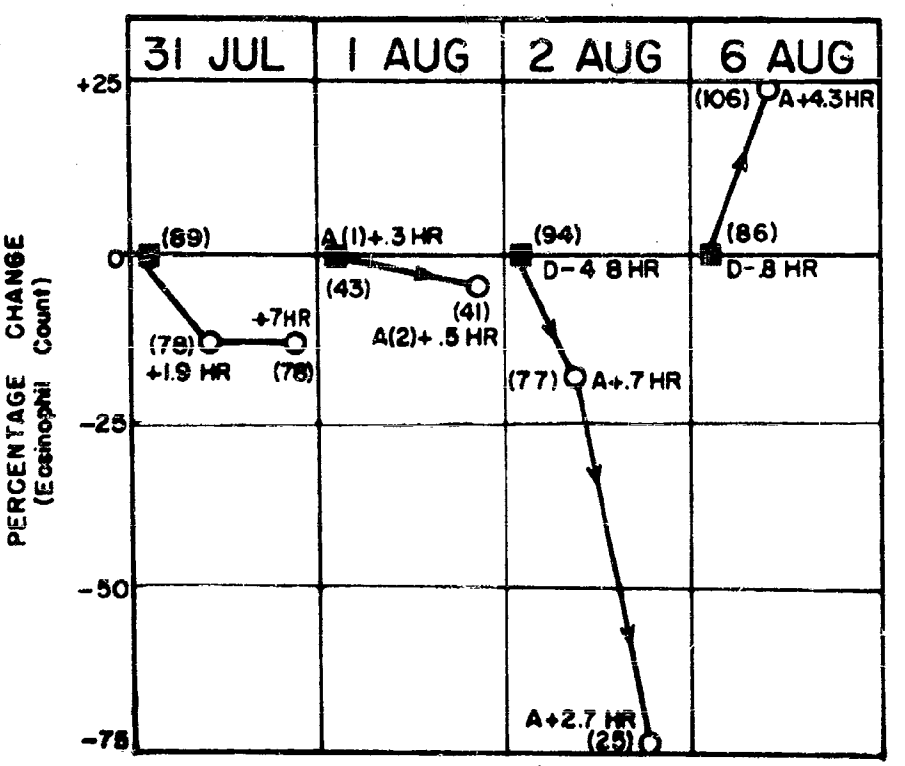

FIGURE 3. *Subject M.*

damaged one MIG. He had been almost continuously engaged with the enemy. At 4 hours post-flight he showed a fall in eosinophil count of only 28 percent. On 6 August (table IV) he again flew a difficult combat mission during which time he destroyed two MIGs. He had pressed forward his second successful attack on the mission despite the increasingly accurate fire of an additional MIG on his tail. Indeed, it was the cannon fire of this latter MIG which was responsible for subject W's second kill of the mission. At one-half hour after the conclusion of this mission, his eosinophil count was 341 cells/mm.^{3} This count, judged in terms of the appropriate nonflying day data, suggests the absence of an eosinopenia following a most difficult combat mission. Subject W appeared to be universally respected within his squadron because he was extremely bold in battle and because he had demonstrated that he would voluntarily disregard his own personal safety during a combat mission to shield a colleague in need of protection. Several months

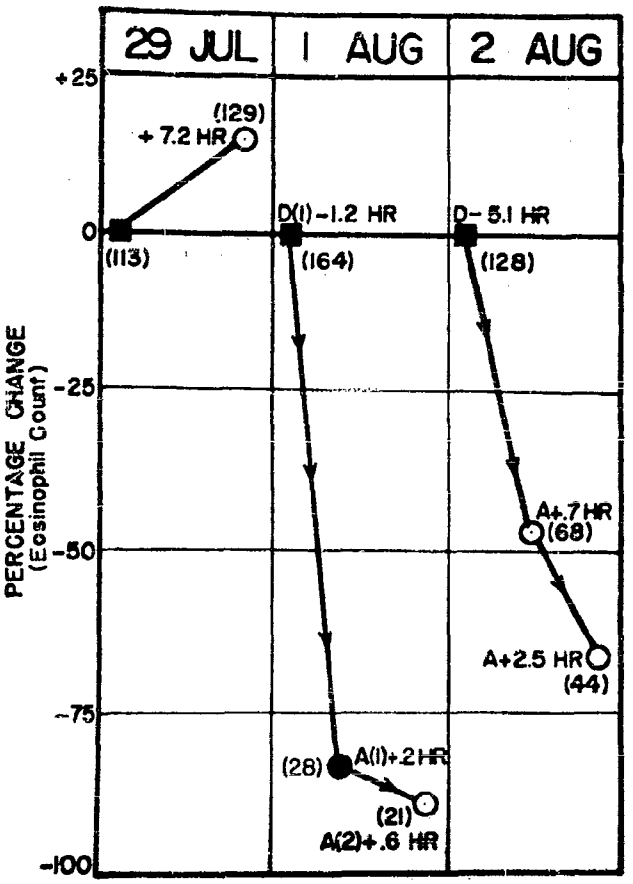

FIGURE 4. *Subject A.*

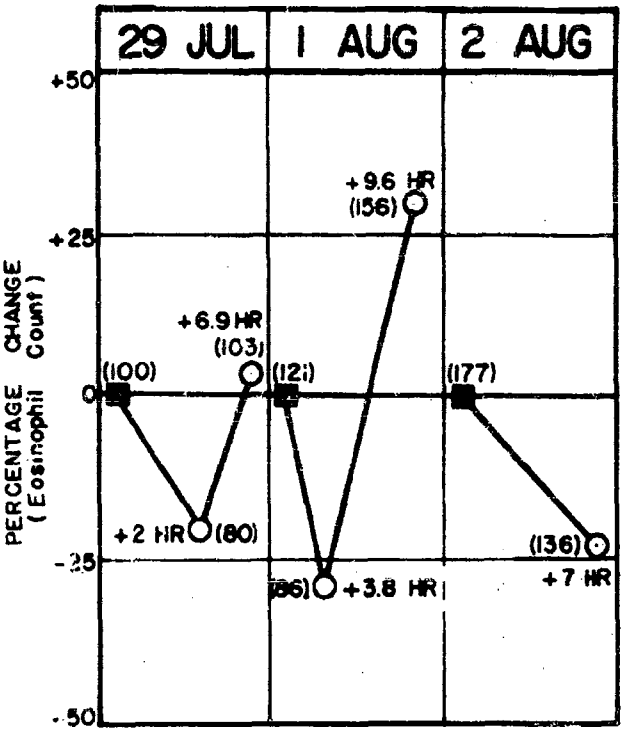

FIGURE 5. *Subject T.*

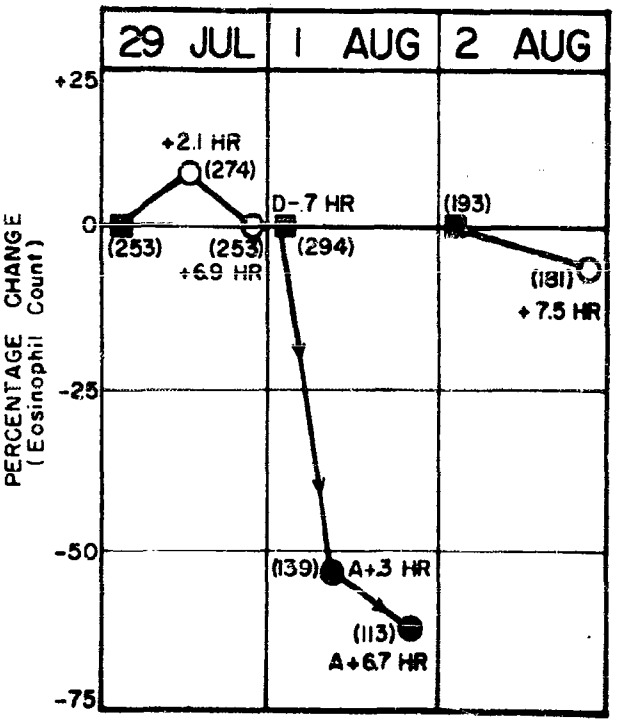

FIGURE 6. *Subject L.*

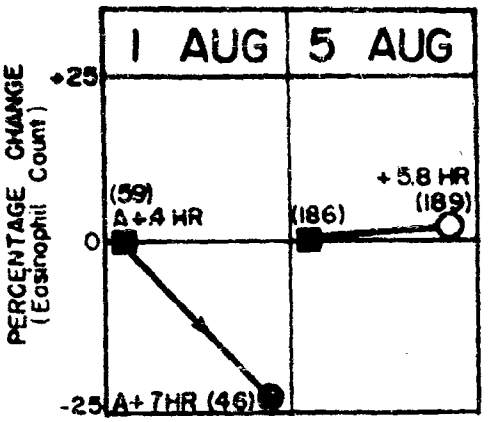

FIGURE 7. *Subject O.*

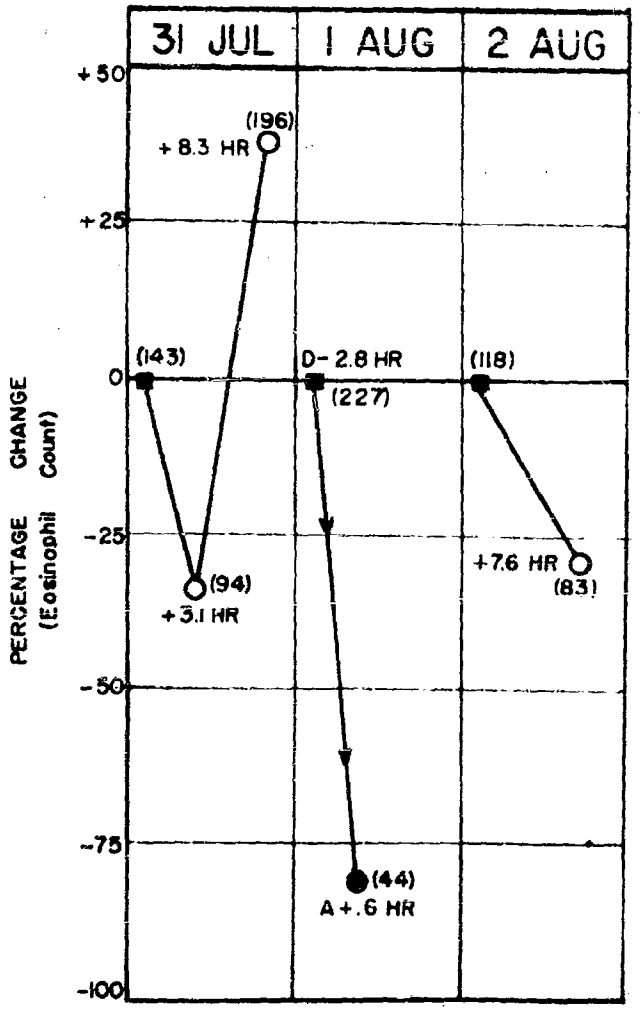

FIGURE 8. *Subject R.*

after the conclusion of this study we had a chance meeting with this subject at an Air Force base in the zone of the interior where subject W was serving as a gunnery instructor in F-80's. He was full of vague complaints over his current assignment and his talk was devoid of the zest for flying which had so much characterized him in Korea. He expressed the wish that he might return to combat.

Subject J (figure 11) flew a difficult combat mission on 5 August, and two routine combat missions on 3 August. The difficult combat mission constitut[illegible]is subject's first shooting encounter with

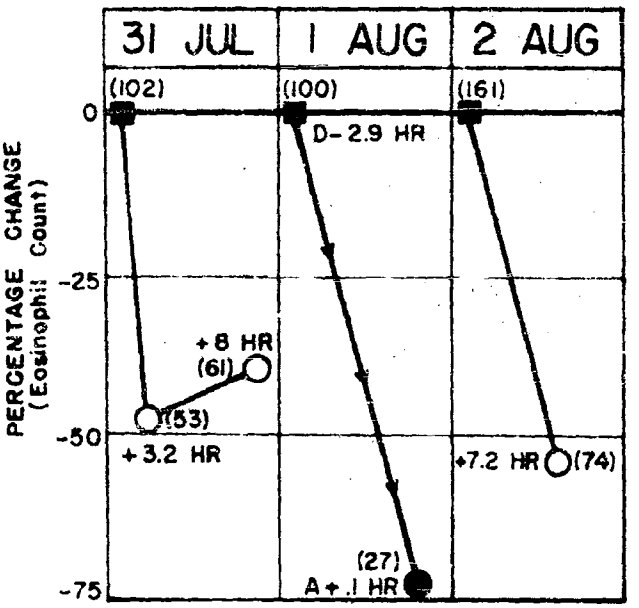

FIGURE 9. *Subject S.*

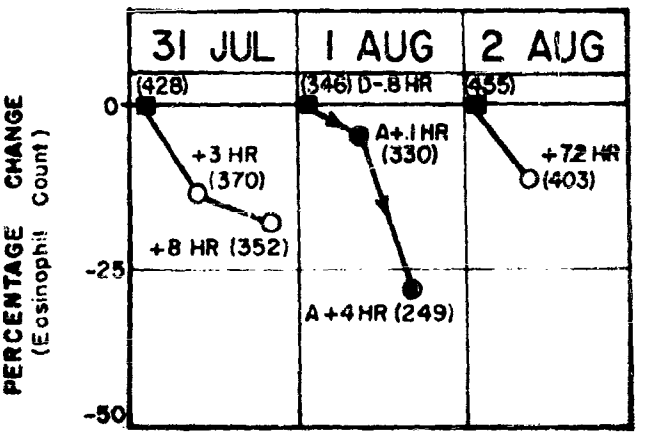

FIGURE 10. *Subject W.*

MIGs. His flight had been scrambled and had sighted a total of twenty MIGs, some of which were receptive to making battle. One MIG was destroyed by the flight leader. Subject J was attacked by two MIGs and subsequently pursued others unsuccessfully. No pre-flight count was drawn for this mission.

The first of the routine combat missions had been "particularly easy." Flying as a *spare*, subject J had been required to make only a relatively shallow penetration over enemy territory, whereupon he orbited. About three hours later he flew the second mission of the day. The latter was an "average" combat mission. Despite some radio reports of potential opposition, there were no sightings. A post-flight count drawn at the conclusion of the second routine combat mission showed a sharp increase (48 percent) over the pre-flight count. The upward surge was again evident at 3.9 hours post-flight. This suggests the existence of a pre-flight strain which became relieved in the course of actual job performance. Data derived from the 5 August mission suggest a like pattern of eosinophil response.

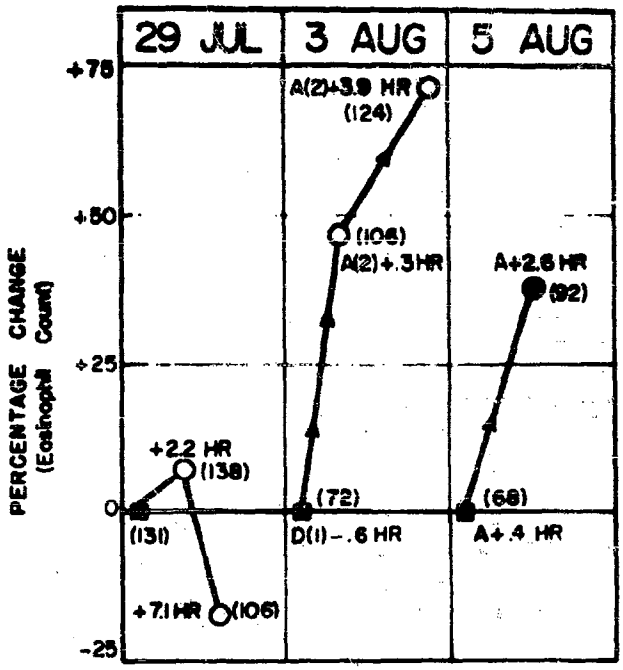

FIGURE 11. *Subject J.*

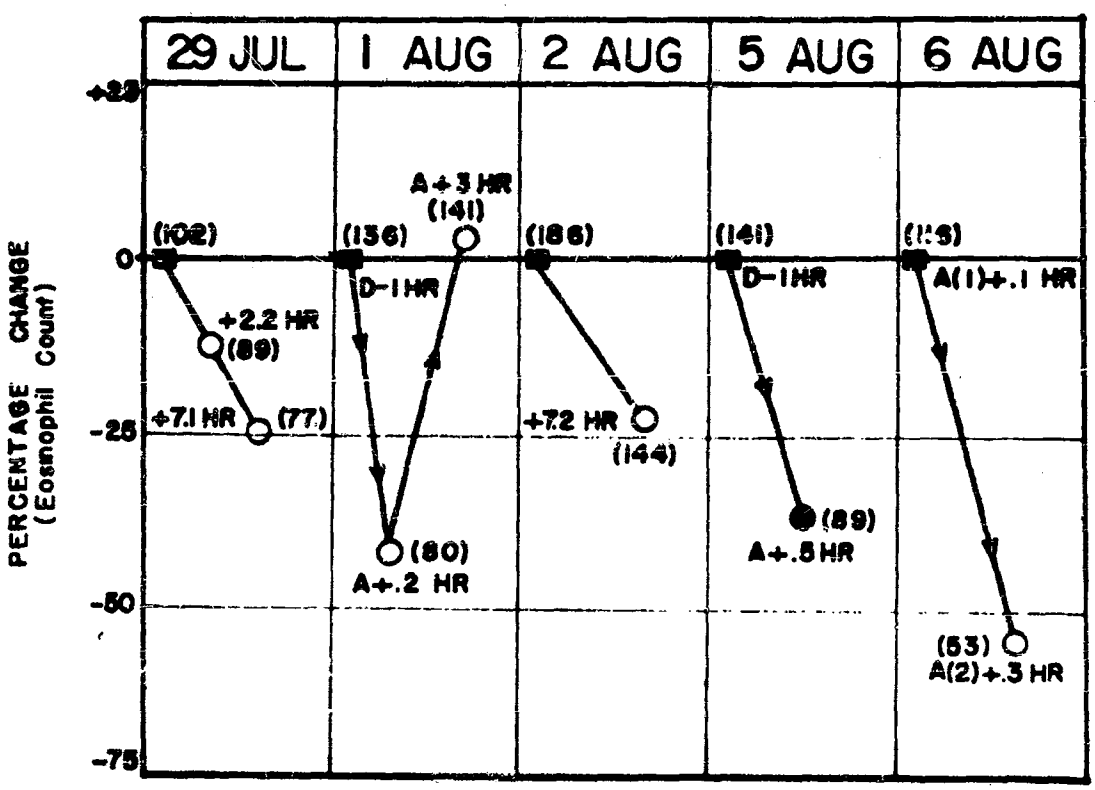

FIGURE 12. *Subject H.*

Subject H (figure 12) showed only a moderate response to a routine combat mission (1 August) and to a difficult combat mission (5 August). He judged the routine combat mission to have been "more difficult than most" because he had to fly just below an overcast, with its attendant threat of MIGs in hiding. During the mission flown on 5 August, subject H saw a total of 11 MIGs. Two of these made passes at him, but in each case they were "too high" for retaliatory action. This mission was also regarded as having been more difficult than most because of the MIG activity. On 6 August subject H showed an eosinopenia following the second of two missions flown on that day. The missions were flown less than three hours apart. The first of these was a difficult combat mission during which he fought with three MIGs, but had to break off and leave the area early because his wingman "lost him." Subject H said that this was an "about average" mission, except that he was extremely angry because of his wingman's failure. No pre-flight count was drawn for this mission. The second mission of the day was a routine combat mission. Subject H patrolled at 31,000 feet, watching over fighter bombers. At different times he sighted MIGs—a total of eight. On this mission, subject H acted as flight leader; on previous missions he had flown as an element leader. The count drawn at 18 minutes post-flight was the lowest (53 cells/mm.^{3}) ever observed for this subject.

On 6 August, subject X (figure 13) flew 3 missions. The same subject suffered a flame-out during the single mission flown on 1 August. On the latter mission he had flown as a spare. During much of the flight the tachometer had been "out" and he had flown entirely by tail-pipe temperature. The flame-out occurred at the end of the mission. In the process of landing, all of his tires were blown out. There had been no demonstrable physical injury to the pilot. A count drawn at 6 minutes after landing showed an eosinophil decline of 54 percent. At 4 hours post-flight, the change was more severe (−74 percent). At approximately 7 hours post-flight, the count had ceased to fall. On this mission, subject X flew with a cold, a circumstance which may account for the relatively high initial count seen on this day. The first of the three missions which he flew on 6 August was an abbreviated routine combat mission on which he flew as a spare. He had to return home early because of *bung tanks*. The second was a difficult combat mission during which his flight destroyed two MIGs. Subject X, suspicious of evasive action by one of the MIGs destroyed, followed it until it crashed into the ground. However, it was not his kill. During the return to the base subject X exhausted his fuel supply and had to land

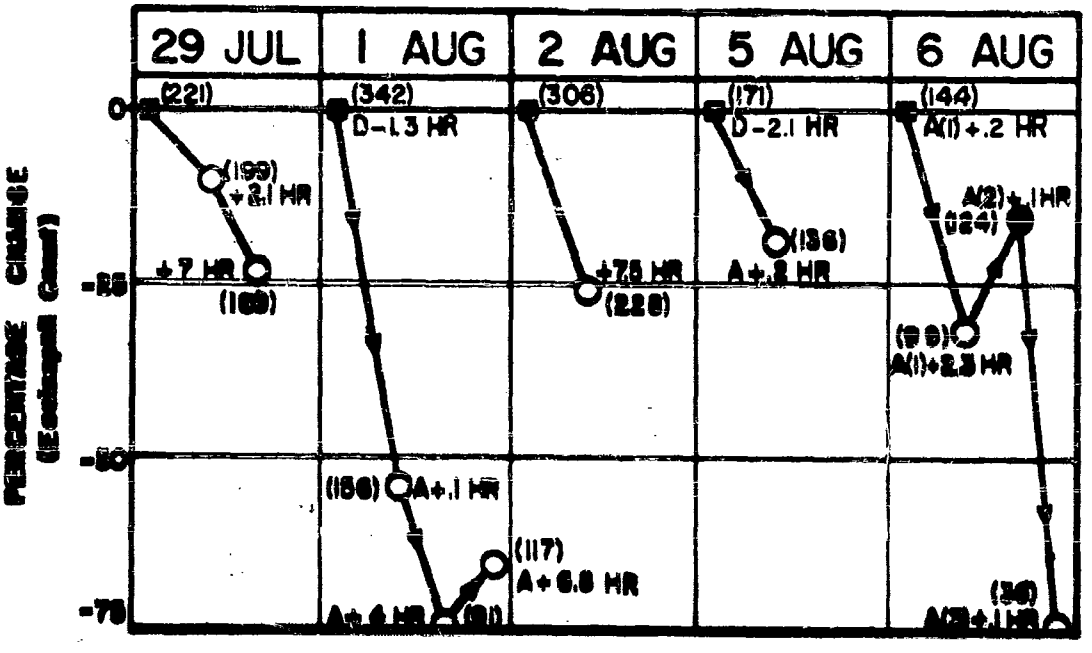

FIGURE 13. *Subject X.*

without power. The third was a routine combat mission devoid of sightings, but the subject complained convincingly of feeling very tired. Subject X described the second mission as having been "without a doubt the worst of all" F–86 missions he had flown. He said that he had not been conscious of fear during that mission, but that it had been "damned hard." As to his physical condition on 6 August this subject said that at the conclusion of the third mission he felt that "it" (the cold) was coming back, and that he was "extremely tired." His general appearance and bearing confirmed this assertion. At the completion of the third mission, a pronounced eosinopenia was present. It is not clear whether the latter mirrored a response to the second or to the third mission or to the cumulative effects of a very arduous day of flying.

Subject A (figure 4) flew two missions on 1 August; a difficult combat mission followed by a *weather* mission less than three hours later. During the first of these subject A was almost constantly engaged with MIGs. It was his fifth shooting encounter with the enemy, but this was the first time that he had been "run off on occasion." Also, his

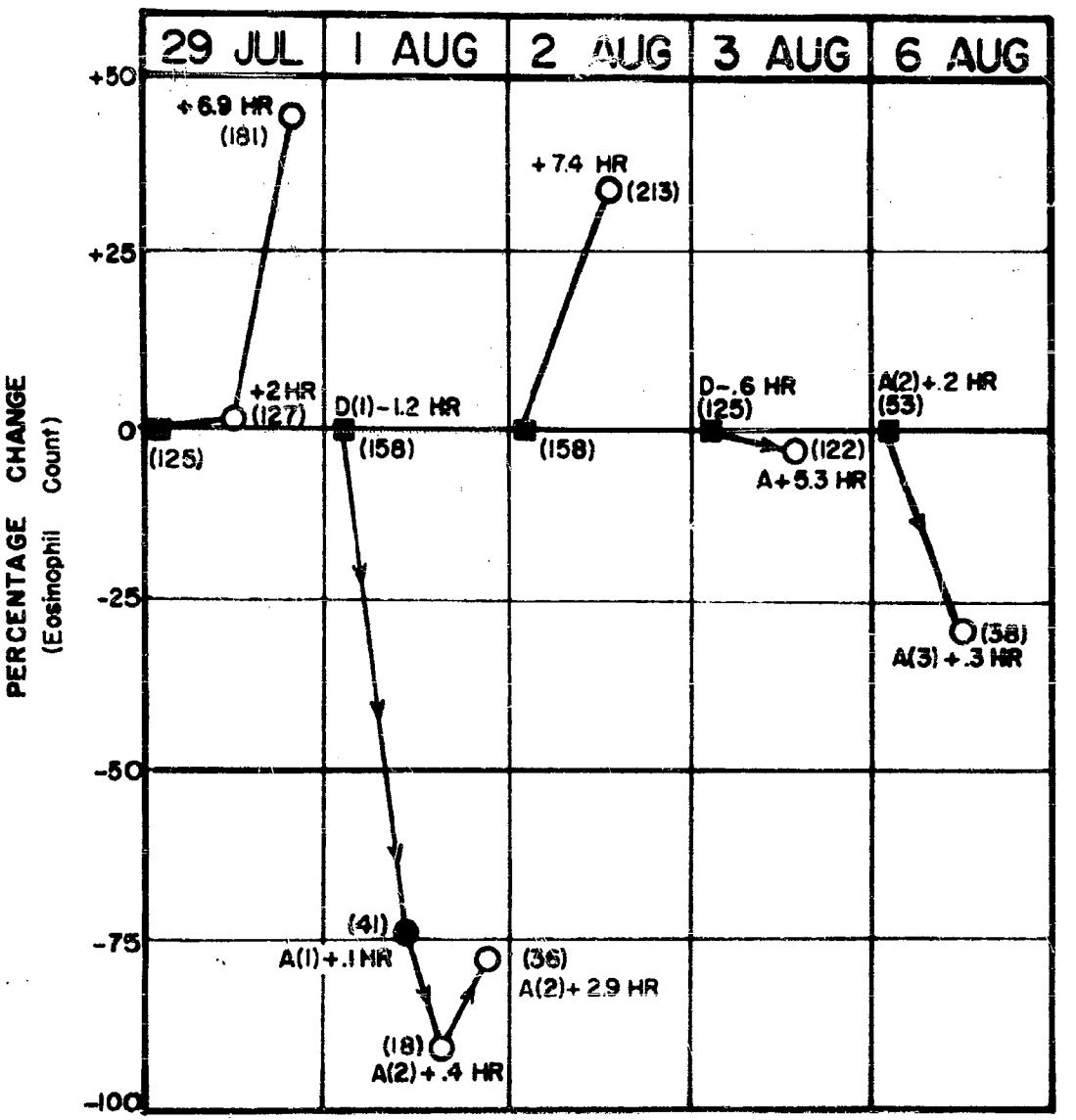

FIGURE 14. *Subject B.*

gunsight was not functioning. A very pronounced eosinopenia was present at the conclusion of both this and the succeeding mission. About two-thirds of the *weather* mission had been flown in clouds.

Subject B (figure 14) provides another example of a pilot flying three combat missions during a single day (6 August). The first and last of these were routine combat missions. The second mission included a very brief encounter with a MIG. Additionally, however, the latter mission was airborne during a period (approximately two hours) of extremely intense enemy activity. During that hectic period at least five MIGs were destroyed and two F-86's sustained damage from MIG cannon fire. Despite the numerous radio reports of MIGs in this area, subject B failed to sight any, except the one already mentioned. This circumstance provoked "some sweat" and caused him to describe the mission as having been "more difficult than most" of his F-86 combat missions. The first eosinophil count of the triple mission day was drawn upon the conclusion of the second mission, at which time the count was much depressed (53 cells/mm.^{3}). Subject B, like subject X, complained of great tiredness at the end of his third mission. Eosinopenia was also present at the conclusion of his difficult combat mission flown on 1 August. During the latter mission he had been almost constantly engaged with the enemy; terminally he withdrew from a "good scrap" because of complete radio failure. Additionally, it will be observed that the diminished count persisted through and beyond the subsequent routine combat mission flown on the same day. The routine combat mission flown on 3 August appears not to have been associated with an eosinopenia.

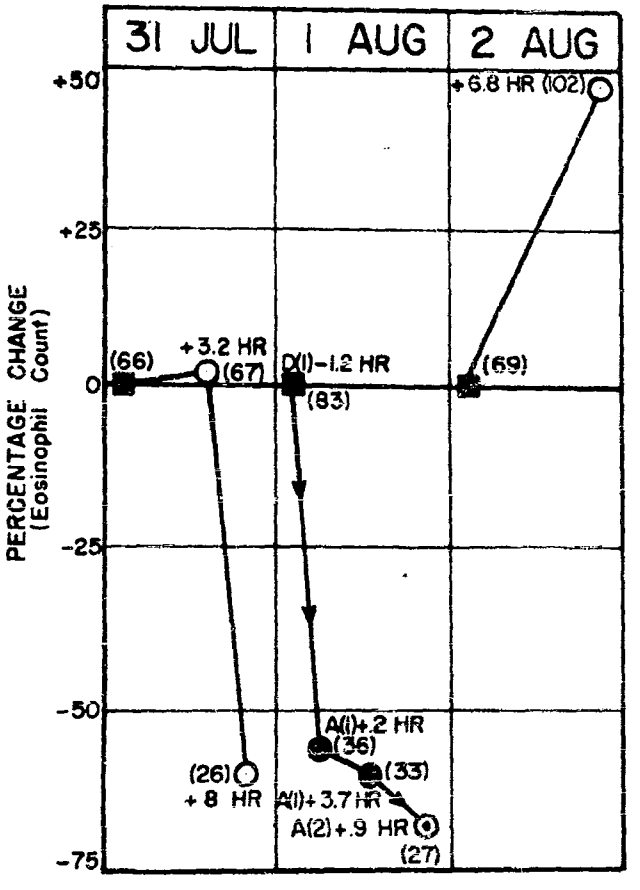

FIGURE 15. *Subject I.*

Findings on subject I (figure 15) are complicated by the presence of a persistent diarrhea, "stomach upset," and vomiting during the three days of observation and during the preceding five days. According to the subject, he had suffered a weight loss of approximately 20 pounds during the two weeks prior to 1 August. During the late afternoon of the first nonflying day (31 July) a severe eosinopenia was observed. A comparable eosinopenia was seen at midmorning of the next day, at 0.7 hours after subject I had completed a difficult combat mission. During this mission he destroyed his first MIG, and "had a hard time escaping MIGs, coming back." It was on this mission that his squadron commander ("a good friend") was lost in action. In addition, his gunsight did not function throughout the mission. Subject I said that after landing, he felt "a little excitement" over having gotten his first MIG, but he maintained, rather inconsistently, that he had suffered "no sweat" over this mission, that it had been "about average." On the second nonflying day (2 August) subject I had been on *alert* duty for approximately five hours prior to the time (0925 hours) that the initial count was drawn. Thereafter he remained on alert for an additional 1.5 hours, took a sedative, and went to bed. He had not flown. He was awakened at 1600 hours and a second blood specimen was drawn. The resultant count (102 cells/mm.^{3}) was the highest observed during his test period and represented an increase of 48 percent over the early morning count. Subject I had ingested no food since the preceding evening (supper). Several days later he volunteered that he was no longer ill, but avoided further testing.

Subject N (figure 16) had been added to the list of subjects at the suggestion of the Wing Commander. Approximately one month prior to the time that he was studied, subject N and his wingman

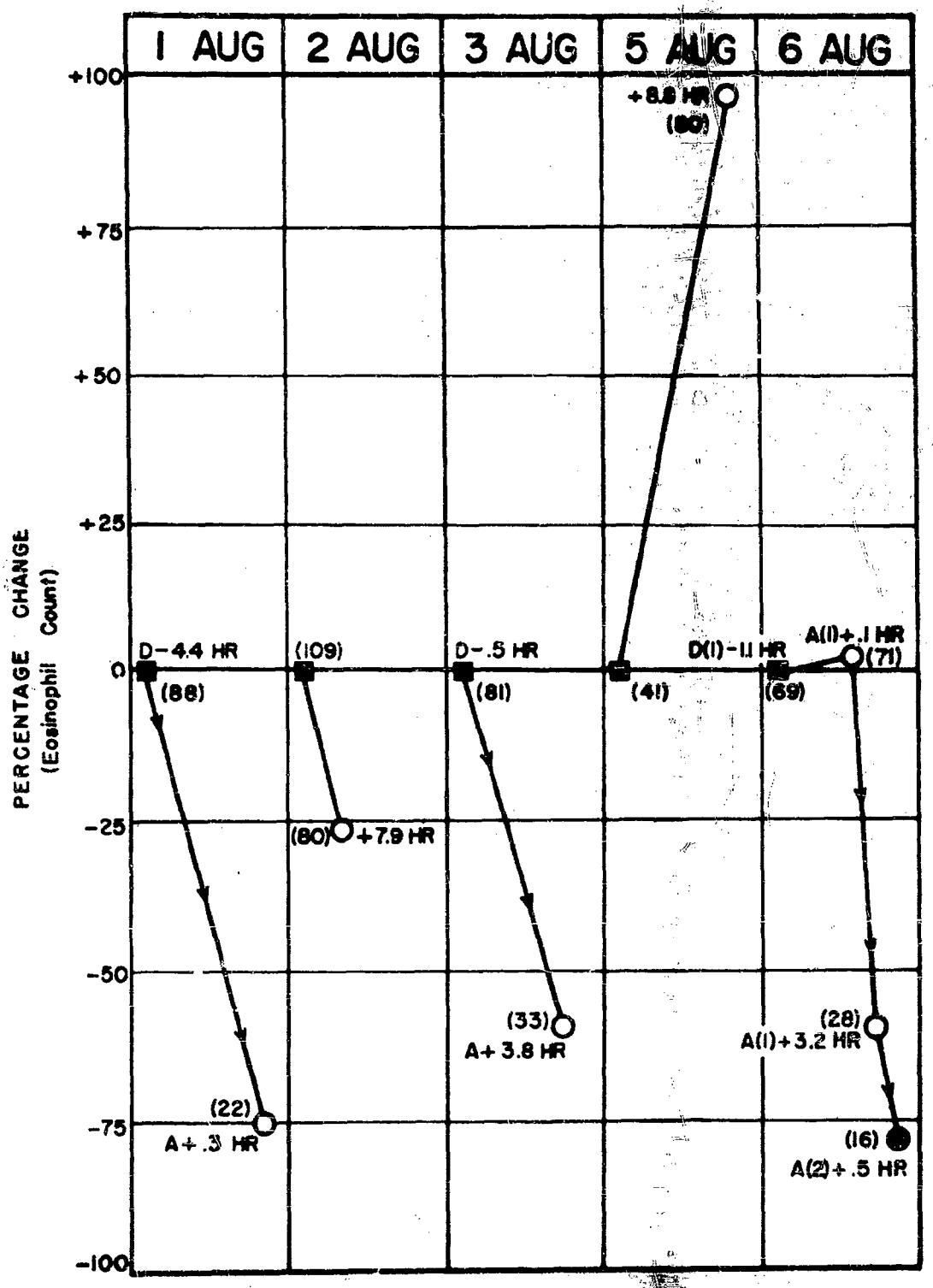

FIGURE 16. *Subject N.*

had been shot down in combat. Both pilots had bailed out successfully over water, but the wingman died by drowning. Subject N was reported as having been deeply affected by the latter event, and it was the opinion of some of his colleagues that he was still concerned about the tragedy. Subject N appeared to be aware of such thinking and made it clear that he regarded the blood tests as being aimed at an evaluation of the existence within him of a state of being "shook up." There was no cause for believing that his combat flying had been deficient as to aggressiveness. Following a routine combat mission on 1 August, his eosinophil count was 22 cells/mm.[3] On 3 August he flew another routine combat mission; again there was a post-flight eosinopenia (33 cells/mm.[3]). On 6 August this subject flew two missions: a routine combat mission followed by a difficult combat mission. Approximately five hours separated the two missions. On this day there was no striking diminution in eosinophils immediately after the conclusion of the routine combat mission. At 3.25 hours post-flight the count had dropped to 28 cells/mm.[3] but it is not certain that this subsequent drop represented a delayed response to the mission. At the time that the latter count was being drawn subject N questioned the value of this count since he had been "very much excited" by the de-briefings of pilots returning from early afternoon missions which had been marked by intense combat activity. On his second mission of the day, a difficult combat mission, he damaged one MIG and expressed some concern over having been low on fuel, coming home. Post-flight, there was an intensification of the eosinopenia seen earlier in the day.

In the case of subject D (figure 17) routine combat missions were not associated with an eosinopenia. The latter of these (6 August; first mission) he regarded as having been "easier than most," although he had experienced some physical discomfort attributed to faulty cabin pressurization. His second mission on 6 August was a difficult combat mission during which he attacked and was attacked by MIGs. He regarded this mission as having been "more difficult than most," not because of his contact with the enemy, but because he had been totally without cabin pressurization while compelled to fly at an altitude of 37,000 to 40,000 feet. He said that he had suffered "slight bends." His post-flight count showed a decrease of only 34 percent as compared with a count drawn approximately two hours prior to take-off for this mission. In summary, no eosinopenic response was shown or indicated by this subject following either routine combat missions or a difficult combat mission, nor to a combination of a routine and a difficult combat mission flown within a time span of about eight hours.

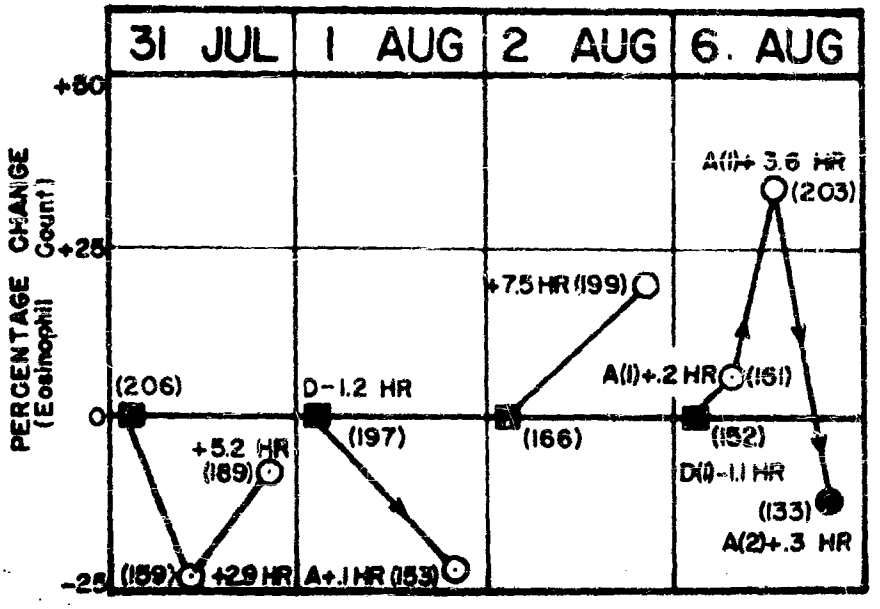

FIGURE 17. *Subject D.*

COMMENTS

We have reviewed the data for evidence of a relationship between eosinopenia and the quality of combat performance of the pilots concerned. For this purpose we have attempted to isolate a relatively homogeneous group of combat missions. The mission flown by subject I was eliminated because of the frank illness of that pilot. Subject N was considered to be atypical of the group because of his apprehension over the imagined purpose of the tests, as well as his generally hectic pre-flight activities as assistant operations officer (Squadron). Subjects P and Z were *too new* (table III) for a reliable evaluation of effectiveness in combat. The mission on which subject X had suffered a flame-out was not used, since such a happening might obscure the residual character of the mission. *Weather* missions were eliminated for much the same reason. Second and third missions flown during a single day were eliminated whenever there existed the possibility of an interpretative error due to possible carry-over effects of a prior mission. Additionally, a mission was excluded unless the initial post-flight count had been drawn relatively soon (0.1 to 1.3 hours; average 0.3 hour, with only 1 post-flight count drawn later than 0.7 hour after arrival). This was done in order to provide relative uniformity with respect to the time allowed for an eosinophil response to become manifest. On the basis of such selection there emerged a group of 19 missions which had been flown by 16 pilots. These missions are identified by an asterisk (*) in table IV. For 11 of the stated missions the pre-flight count had been drawn at 1.4 hours or less (0.7 to 1.4 hours; average 1.1 hours) prior to the actual time of departure. For three of the missions this relationship was 2.1, 2.8, and 2.9 hours, respectively. Two of the missions, each flown by a different pilot, had been preceded by a prior mission (same day). For one of the subjects (subject D) the second of these serial missions had been flown 5.3 hours following the conclusion of the earlier mission; for the other subject (subject J) the interval was 3.3 hours. For the three remaining missions pre-flight counts had not been drawn, but the post-flight counts (43, 44, and 59 cells/mm.^{3}) were so low, either in an absolute sense or in relation to nonflying day counts, that the existence of an eosinopenia was rather clearly indicated. The relationship between post-flight eosinopenia and the nature of the mission flown may be summarized as follows:

1. ***Eosinopenia absent following a difficult combat mission:*** Subjects D, H, and W.

2. ***Eosinopenia absent following a routine combat mission:*** Subjects C, D, (2 missions), H, J, K, and X.

3. ***Eosinopenia present following a difficult combat mission:*** Subjects A, B, L, M, O, R, and S.

4. ***Eosinopenia present following a routine combat mission:*** Subjects E and T.

Operationally, subjects C and W were *superior* combat pilots; subjects A, B, D, H, J, K, O, R, and X were judged to be *average* or *better than average* combat pilots; subjects E, L, and M were *weak* combat pilots. Subjects S and T were *very weak* as combat pilots and, as such, were removed from flying status prior to the conclusion of the collection of these data. For practical purpose we may combine the *superior* and *average* or *better than average* combat pilots into a single group which we might label "Group A." The *weak* and *very weak* combat pilots may be similarly combined to constitute a second group, "Group B." Of the 9 routine combat missions in this series, only 2 were associated with an eosinopenia; both of these had been flown by members of Group B. Of the 10 difficult combat missions in this series, 3 were not associated with an eosinopenia; these had been flown by Group A pilots. In summary, we may say that in the case of the routine combat mission, eosinopenia was significantly associated with Group B pilots ($P < .01$). The absence of an eosinopenia following a difficult combat mission was confined to Group A pilots.

In connection with the missions singled out in this section, it would seem to be necessary to further clarify the time relationships which pertain to the eosinophil counts concerned. The approximate flying time for each of these combat missions was less than two hours. Between pre-flight and initial post-flight eosinophil counts, approximately three hours elapsed. If a post-flight eosinopenia reflected an in-flight strain, and if the in-flight stress became functional very soon after the pilot became airborne, then the schedule of counts was such as to permit about two hours for the strain to become manifest. If and when the stress became functional prior to actual take-off, the time allowed for the strain to become recognizable by the test employed would have been longer. The matter of *when* to test for an evidence of a meaningful eosinophil response requires further investigation. The schedule of counts employed in this study should be regarded as an intermediate step in the process of learning in this area—not as a final choice.

Ideally the definition of an *eosinopenia* might be expected to comprehend the duration of the stress

and the time intervening between cessation of the stress and testing. These demands are the easier satisfied when the investigator administers a well-defined entity such as ACTH, cortisone, or epinephrine. When naturally occurring stresses are involved, the problem is more complicated. We do not know at what point in the course of a mission a pilot begins to respond to the stress involved, nor do we know the duration of the stress impinging upon a receptive individual. Moreover, the stress cannot be metered as one measures out the dosage of ACTH to be administered. We cannot even assume that the completion of a mission necessarily marks a cessation of the application of the stress originating in or prior to the act of flying. For reasons such as these there is the felt need to learn more about the test intervals that can be used to best advantage for most cases.

The problem of the magnitude of the decrease in eosinophil count, which we shall regard as being an eosinopenic reaction, requires additional testing. It also requires an agreement as to the objectives to be achieved by the testing program. *Eosinopenia* should be so defined that this phenomenon will not be confused with inherent technical error, alterations due to diurnal variation, or a combination of these factors. At the present time we have no reason for believing that the criterion used in this paper, a 50 percent decrease in circulating eosinophils, fails to achieve the objectives just stated. However, this does not dispose of the total problem raised. Additionally it must be decided whether the identification of the existence of a state of strain is to be limited to an identification of strain associated with an antecedent stress of overwhelming proportions or whether one will use the test to distinguish between individual members of a given population engaged in the performance of an essentially homogeneous group of activities. In the latter case one may not be satisfied with a criterion of eosinopenia derived from the study of major aircraft accidents or from cases involving a critical malfunction, such as a flame-out. In the present study a fall in count of more than 50 percent at about one-half hour after the conclusion of a mission of less than two hours' duration, would appear to provide a functional if imperfect means of distinguishing between broad categories of pilots. It is to be observed moreover that, in general, pilots who showed an eosinopenia so defined suffered a fall in count of considerably more than 50 percent. For the cases identified by asterisk in table IV, the range was −53 to −83 percent for an average of −71 percent. In contrast, pilots showing a drop in count of less than 50 percent following a combat mission provided a range of +48 to −41 percent, the average being −16 percent.

We have searched our data for evidence of the influence of altitude upon the eosinophil response. Missions were grouped according to the maximum altitude achieved and maintained for approximately one-fourth to one-half of a given mission. Such data were available for the several missions identified by the asterisk in table IV. Oxygen was of course utilized continuously during all of the missions studied. Nine of the 19 missions had been flown at an altitude of 35,000 feet or higher. Five of the 9 missions were associated with an eosinopenia; of these 4 were difficult and 1 was a routine combat mission. Four of the 9 missions were not associated with an eosinopenia; of these, 2 were difficult and 2 were routine combat missions. Three of the 19 missions had been flown at 40,000 feet or higher. One of the 3 missions was associated with an eosinopenia—a difficult combat mission. Two of the 3 missions were not associated with an eosinopenia; one of these was a difficult and the other was a routine combat mission. It is emphasized that the altitudes referred to above constitute altitudes achieved and maintained during approximately one-fourth to one-half of the respective missions. On the basis of these limited data it is not possible to discern a critical relationship between eosinopenia and the altitudes discussed.

The distinction between routine and difficult combat missions was derived from an on-the-spot examination of the kinds of F−86 missions flown in Korea. The resultant definitions, previously stated, are independent of the eosinophil findings. There is moreover the emergence of a challenging relationship between eosinopenia in these subjects and their rating as combat pilots. This cumulative promise must be tempered by a full awareness of our continued ignorance of the interpretative limitations of the eosinophil count. Sorely needed, too, is an understanding of the mechanism responsible for the eosinopenia observed. In the present study, the antecedent stress would appear to be heavily colored by the presence of an arduous mental process.

ACKNOWLEDGMENT

The collection of these data depended upon the active cooperation of several organizations and of many persons. To each of these we express gratitude and appreciation. Hq. FEAF provided us with the opportunity to make the study. The Air University Far East Research Group gave very valuable administrative assistance in the planning

and execution of our schedule. The Commanding Officer and staff of the F-86 unit studied, willingly tutored us concerning various aspects of each day's engagements and the air war as a whole. The attendant Flight Surgeon facilitated our work in countless ways. The Commanding Officer of the adjacent medical group, along with his hospital staff, graciously shared with us their limited laboratory facilities and supplies. To the pilots who were our subjects and to their colleagues who suffered our constant presence, we extend the warmest of our thanks.

The eosinophil counts herein reported were performed by the following senior medical laboratory specialists: S/Sgt. Lyle D. Hansen, A/1C Joseph J. Law, and A/1C Hubert D. Reese. We wish to express our additional thanks to A/1C Reese for his execution of the figures used in this manuscript.

We are indebted to David Rubinstein, Department of Biometrics, for the statistical analyses referred to in this study.

REFERENCES

1. Randolph, T.G. The direct counting chamber determination of eosinophils by propylene glycol aqueous stains. J. Allergy 15:89-96 (1944).

2. Domanski, T.J., A.G. Swan, J.G. Wells, and L.B. Hughes. Physiological relationships in human stress response. I. Eosinophil response to muscular activity. USAF School of Aviation Medicine Project No. 21-32-025, Report No. 1., Oct. 1951.

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE MATERIEL COMMAND
WRIGHT-PATTERSON AIR FORCE BASE OHIO

FEB 19 2002

MEMORANDUM FOR DTIC/OCQ (ZENA ROGERS)
8725 JOHN J. KINGMAN ROAD, SUITE 0944
FORT BELVOIR VA 22060-6218

FROM: AFMC CSO/SCOC
4225 Logistics Avenue, Room S132
Wright-Patterson AFB OH 45433-5714

SUBJECT: Technical Reports Cleared for Public Release

References: (a) HQ AFMC/PAX Memo, 26 Nov 01, Security and Policy Review, AFMC 01-242 (Atch 1)

(b) HQ AFMC/PAX Memo, 19 Dec 01, Security and Policy Review, AFMC 01-275 (Atch 2)

(c) HQ AFMC/PAX Memo, 17 Jan 02, Security and Policy Review, AFMC 02-005 (Atch 3)

1. Technical reports submitted in the attached references listed above are cleared for public release in accordance with AFI 35-101, 26 Jul 01, *Public Affairs Policies and Procedures*, Chapter 15 (Cases AFMC 01-242, AFMC 01-275, & AFMC 02-005).

2. Please direct further questions to Lezora U. Nobles, AFMC CSO/SCOC, DSN 787-8583.

Lezora U. Nobles

LEZORA U. NOBLES
AFMC STINFO Assistant
Directorate of Communications and Information

Attachments:
1. HQ AFMC/PAX Memo, 26 Nov 01
2. HQ AFMC/PAX Memo, 19 Dec 01
3. HQ AFMC/PAX Memo, 17 Jan 02

cc:
HQ AFMC/HO (Dr. William Elliott)

DEPARTMENT OF THE AIR FORCE

HEADQUARTERS AIR FORCE MATERIEL COMMAND
WRIGHT-PATTERSON AIR FORCE BASE OHIO

JAN 17 2002

MEMORANDUM FOR HQ AFMC/HO

FROM: HQ AFMC/PAX

SUBJECT: Security and Policy Review, AFMC 02-005

1. The reports listed in your attached letter were submitted for security and policy review IAW AFI 35-101, Chapter 15. They have been cleared for public release.

2. If you have any questions, please call me at 77828. Thanks.

JAMES A. MORROW
Security and Policy Review
Office of Public Affairs

Attachment:
Your Ltr 14 January 2002

14 January 2002

MEMORANDUM FOR: HQ AFMC/PAX
Attn: Jim Morrow

FROM: HQ AFMC/HO

SUBJECT: Releasability Reviews

1. Please conduct public releasability reviews for the following attached Defense Technical Information Center (DTIC) reports:

   a. *Flight Test Program for Model P-86 Airplane Class – Jet Propelled Fighter*, 2 December 1946; DTIC No. AD-B804 069.

   b. *Physiological Recognition of Strain in Flying Personnel: Eosinopenia in F-86 Combat Operations*, September 1953; DTIC No. AD- 020 375.

   c. *Phase IV Performance Test of the F-86F-40 Airplane Equipped with 6x3-inch Leading Edge Slats and 12-inch Extensions on the Wing Tips*, May 1956; DTIC No. AD- 096 084.

   d. *F-86E Thrust Augmentation Evaluation*, March 1957; DTIC No. AD- 118 703.

   e. *F-86E Thrust Augmentation Evaluation*, Appendix IV, March 1957; DTIC No. AD- 118 707.

   f. *A Means of Comparing Fighter Effectiveness in the Approach Phase*, October 1949; DTIC No. AD- 223 596.

   g. *War Emergency Thrust Augmentation for the J47 Engine in the F-86 Aircraft*, August 1955; DTIC No. AD- 095 757.

   h. *Operational Suitability Test of the F-86F Airplane*, 4 May 1953; DTIC No. AD-017 568.

   i. *Estimated Aerodynamic Characteristics for Design of the F-86E Airplane*, 26 December 1950; DTIC No. AD- 069 271.

   j. *Combat Suitability Test of F-86F-2 Aircraft with T-160 Guns*, August 1953; DTIC No. AD- 019 725.

2. These attachments have been requested by Dr. Kenneth P. Werrell, a private researcher.

3. The AFMC/HO point of contact for these reviews is Dr. William Elliott, who may be reached at extension 77476.

JOHN D. WEBER
Command Historian

10 Attachments:
a. DTIC No. AD-B804 069
b. DTIC No. AD- 020 375
c. DTIC No. AD- 096 084
d. DTIC No. AD- 118 703
e. DTIC No. AD- 118 707
f. DTIC No. AD- 223 596
g. DTIC No. AD- 095 757
h. DTIC No. AD- 017 568
i. DTIC No. AD- 069 271
j. DTIC No. AD- 019 725